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Studies on Controlled Release Fertilizer on Roselle and Amaranthus Plants

Dr.L.Nageswara Rao ^{*1}, D.Kamalakar ²

^{*1,2}Department of Chemical Engineering, RVR&JC College of Engineering(A), Guntur, A.P, India
lnrao1978@gmail.com

Abstract

India needs to raise its food grains targets at a rate of more than 4 million tons per annum. Scope for increase in area under cultivation is negligible. Due to rapid increase of population as well as the drop in the average cultivable land required for farming. Plants require necessary nutrients like Nitrogen, Phosphorus and Potassium for their photosynthesis process the soil should have the capability of providing the essentials in abundant. In this study we are mainly concentrated on the growth of plant, pH, and salinity, amount of nitrogen percent, amount of potassium percent, amount of phosphorous percent present in the soil and how they are helpful to the plant growth and to study the type of effects of these parameters on plant growth.

Keywords: Controlled release fertilizers, Roselle, Amaranthus plants, plant growth.

Introduction

Agriculture is the mainstay of the Indian economy. Two thirds of the Indian population depends on it. India's population is expected to be 1.4 billion by the year 2025. 300 million tons of food grains will be required by 2025. The current food grains production around 241.0 million tons. Herbicides have been used extensively for several years in the commercial production of agronomic and horticultural crops. The use of these chemicals is essential for adequate production of food and fiber crops. An effective herbicides should control weeds at reasonable dosages while reminding selectively non phytotoxic to the crops remain in the area where applied persist throughout the growing season and then dissipate rapidly. Some potentially useful compounds have not been completely successful due to problems associated with selectivity persistence or mobility [1,2].

The fertilizer industry faces a permanent challenge to improve the efficiency of its products. This is done either through improvement of fertilizers already in use or through development of new specific fertilizer. Apart from possible technical problems this is not an easy task due to the mechanisms of plant nutrition. Normally, plants take up nutrients through their roots from the soil and the soil solution. However, soil and plants are two antagonistic systems competing for the nutrients available in the soil or applied [3, 4].

The competition is the main problem whenever nutrients in the form of mineral fertilizers are applied to the soil to feed the plants. This is also the main reason why only a proportion of nutrients is taken up and used by the plants and crops grown. The utilization rate of N in the mineral fertilizer is about 50-70% during the first year. The utilization rate of P mineral fertilizer is 10-20% and also the utilization rate of K in mineral fertilizer is about 50-60% during the first year. It includes the use of the soil and plant testing methods and analysis [5].

Definition of Slow and Controlled release fertilizers

The definition of the slow and controlled release fertilizers are fertilizer containing a plant nutrient in a form which either i) it delays its availability for plant uptake and use after the application ii) which is available to the plant significantly longer than the reference rapidly available nutrient fertilizer such as urea potassium chloride. In the production of slow-release or controlled-release fertilizers the slow-release effect may be obtained by various production processes, for example through modification of conventional fertilizers.

Their solubility, i.e. the release of plant available nutrients is reduced chemically or physically slow or controlled-release or the transformation of less available or less mobile in the soil nutrient forms into plant available or mobile forms is delayed by association. Controlled or slow nutrient release can be achieved through special chemical and physical characteristics. With controlled-release fertilizers the principal procedure is one whereby conventional soluble fertilizer materials are given a protective coating or encapsulation of water insoluble, semi-permeable or impermeable with pores, controlling water penetration and thus the rate of dissolution, and nutrient

release synchronized to the plants need[6,7].

Advantages of the slow and Controlled Release Fertilizers:

- They reduce toxicity particularly to seedlings, which is caused through high ionic concentrations resulting from the quick dissolution of conventional soluble fertilizers.
- In some cases also from ammonia, for instance after application of urea and thus contribute to improved agronomic safety.
- Due to the reduction of toxicity and the salt content of substrates they permit the application of substantially larger than fertilizer dressing's depot fertilization reducing the application frequency as compared to conventional soluble fertilizers.
- This results in significant savings in labour, time and energy, as well as in making the use of the fertilizer more convenient. This latter factor constitutes the greatest advantage for the majority of present consumers of slow- and controlled-release fertilizers.

Disadvantages of the slow and controlled release fertilizers:

- There are no standardized methods for reliable determination of the nutrient release pattern available as yet.
- Broadly speaking there appears to be a lack of correlation between the data resulting from Laboratory testing - which are made available to the consumer - and the actual functioning of the Nutrient release pattern in field conditions.
- Furthermore, when reporting the advantages of slow and controlled release fertilizers in Comparison to conventional mineral fertilizers, controlled-release fertilizers have not always been compared to the best existing fertilizer management practices.
- With regard to chemical reaction products, such as urea- formaldehyde fertilizers, it appears that a Proportion of the nitrogen contained may be released to the soil solution extremely slowly.

Materials and methods

Urea

The commercial synthesis of urea involves the combination of ammonia and carbon dioxide at high pressure to form ammonium carbonate, which is subsequently dehydrated by the application of heat to form urea and water.



First reaction is fast and exothermic and essentially goes to complete under the reaction conditions used industrially. Subsequent reaction is slower and endothermic and does not go to completion. The conversion (on a CO₂ basis) is usually in the order of 50-80%. The conversion increases with increasing temperature and NH₃/CO₂ ratio and decreases with increasing H₂O/CO₂ ratio.

Neem oil

Quality of neem oil depends on the type of extraction. Manufacturing of neem oil includes the collection of raw materials for the extraction and selection of extraction method. Neem oil is extracted from neem leaf and neem seed. Neem seed is widely used in the extraction process instead of neem leaf as the oil content is found to be more in seeds than in the leaf. Neem oil extraction is done by Mechanical pressing, Steam pressure extraction and Solvent extraction. Primary process of extraction consists of grade wise separation of seeds. Grading of seeds is done according to the amount of oil content in the seeds and with sizes as well. Firstly, the fruits are collected in a drum, and the kernels are separated to obtain the seeds. Later the seeds are oven dried and then feed into the oil extracting machine in case of mechanical pressing method. The neem oil is obtained by pressing it mechanically and collected in a drum. Thus filtration is done to remove the various unwanted particles left in the extracted oil in order to obtain pure neem oil[8,9].

Roselle seeds

The Roselle (*Hibiscus sabdariffa*) is a species of Hibiscus native to the Old World tropics, used for the production of bast fibre and as an infusion. It is an annual or perennial herb or woody-based sub-shrub, growing to 2–2.5 m (7–8 ft) tall. The leaves are deeply three- to five-lobed, 8–15 cm (3–6 in) long, arranged alternately on the stems.

The flowers are 8–10 cm (3–4 in) in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1–2 cm (0.39–0.79 in) wide, enlarging to 3–3.5 cm (1.2–1.4 in), fleshy and bright red as the fruit matures. It takes about six months to mature.

Many parts of the plant are also claimed to have various medicinal values. They have been used for such purposes ranging from Mexico through Africa and India to Thailand. Roselle is associated with traditional medicine and is reported to be used as treatment for several diseases such as hypertension and urinary tract infections[10].

Although Roselle has well documented hypertensive effects, there is currently insufficient evidence to support the benefit of Roselle for either controlling or lowering blood pressure due to a lack of well designed studies that measure the efficacy of Roselle on patients with hypertension.

Amaranthus seeds

Amaranthus, collectively known as amaranth, is a cosmopolitan genus of annual or short-lived perennial plants. Catkin-like cymes of densely packed flowers grow in summer or autumn. Approximately 60 species are recognized, with inflorescences and foliage ranging from purple and red to green or gold. Members of this genus share many characteristics and uses with members of the closely related genus Celosia. Although several species are often considered weeds, people around the world value amaranths as leaf vegetables, cereals, and ornamental plants.

"Amaranth" derives from Greek (Amaranthus), "unfading," with the Greek word for "flower," factoring into the word's development as "amaranth." The more accurate "Amaranthus" is an archaic variant.

Experimental procedure

- Take a clean beaker add both neem oil and urea in the ratio of 1:5 respectively.
- Then mix it uniformly and keep it in shade for about 3 hours.
- Now the coated urea is ready. Then apply this to plants.
- Kept these plants under observation.
- Measure the height of the plant for a constant time period says (7 days).
- Collect the soil samples consecutively for every seven days.
- Perform the soil analysis tests for knowing pH, electrical conductivity, amount of nitrogen, amount of potassium, and amount of phosphorous. Record the readings.
- Same neem oil coated urea is applied to two types of the plant ROSELLE, AMARANTHUS.
- Parameters discussed above are recorded for the plants in two other sets that are applying urea to two types of plant and without applying fertilizer to two types of plant.
- Compare the results by using graphical methods.

Soil analysis

Sampling procedure

Prepare a map of the area to be covered in a survey showing different sampling unit boundaries. A plan of the number of samples and manner of composite sampling is entered on the map, different fields being designated by letters A, B, C etc. Each area is traverse separately. A slice of the plough-layer is cut at intervals of 15 to 20 steps or according to the area to be covered. Generally 10 to 20 spots must be taken for one composite sample depending on the size of the field. Scrap away surface obtain a uniformly thick slice of soil from the surface to the plough depth from each place. A V-shaped cut is made with a spade to remove 1 to 2 cm slice of soil. The sample may be collected on the blade of the spade and put in a clean bucket. In this way collect samples from all the spots marked for one sampling unit. In case of hard soil, samples are taken with the help of augur from the plough depth and collected in the bucket. Pour the soil from the bucket on a piece of clean paper or cloth and mix thoroughly. Spread the soil evenly and divide it into 4 quarters. Reject two opposite quarters and mix the rest of the soil again. Repeat the process till left with about half kg of the soil, collect it and put in a clean cloth bag. Each bag should be properly marked to identify the sample. The bag used for sampling must always be clean and free from any contamination. If the same bag is to be used for second time, turn it inside out and remove the soil particles [13].

Precautions

- Do not sample unusual area like unevenly fertilized, marshy, old path, old channel, old bunds, area near the tree, and site of previous compost piles and other unrepresentative sites.
- For a soft and moist soil, the tube auger or spade is considered satisfactory. For harder soil, a screw auger may be more convenient.
- Where crops have been planted in rows, collect samples from the middle of the rows so as to avoid the area where fertilizer has been band placed.

Avoid any type of contamination at all stages. Soil samples should never be kept in the store along with fertilizer materials and detergents. Contamination is likely when the soil samples are spread out to dry in the vicinity of stored fertilizers or on floor where fertilizers were stored previously. Before putting soil samples in bags, they should be examined for cleanliness as well as for strength. Information sheet should be clearly written with copying pencil.

Preparation of Soil samples for analysis**Handling in the laboratory**

As soon as the samples are received at the soil testing laboratory, they should be checked with the accompanying information list. If the soil testing laboratory staffs have collected the samples themselves, then adequate field notes might have been kept. All unidentifiable samples should be discarded. Information regarding samples should be entered in a register and each sample be given a laboratory number, in addition to sample number, which helps to distinguish if more than one source of samples is involved.

Drying of samples

Samples received in the laboratory may be moist. These should be dried in wooden or enamelled trays. Care should be taken to maintain the identity of each sample at all stages of preparation. During drying, the trays can be numbered or a plastic tag could be attached. The soils are allowed to dry in the air. Alternatively, the trays may be placed in racks in a hot air cabinet whose temperature should not exceed 350 C and relative humidity should be between 30 and 60%. Oven drying a soil can cause profound change in the sample. This step is not recommended as a preparatory procedure in spite of its convenience. Drying has negligible effect on total N content but the nitrate content in the soil changes with time and temperature. Microbial population is affected due to drying at high temperature. With excessive drying, soil potassium may be released or fixed depending upon the original level of exchangeable potassium. Exchangeable potassium will be increased if its original level was less than 1 meq/100 g soil (1 cmol/kg) and vice-versa, but the effect depends upon the nature of clay minerals in the soil. In general, excessive drying, such as oven drying of the soil, affects the availability of most of the nutrients present in the sample and should be avoided. Only air drying is recommended. Nitrate, nitrite and ammonium determinations must be carried out on samples brought straight from the field. These samples should not be dried. However, the results are expressed on oven dry basis by separately estimating moisture content in the samples.

pH Analysis:

Calibrate the pH meter, using 2 buffer solutions, one should be the buffer with neutral pH (7.0) and the other should be chosen based on the range of pH in the soil. Take the buffer solution in the beaker. Insert the electrode alternately in the beakers containing 2 buffer solutions and adjust the pH. The instrument indicating pH as per the buffers is ready to test the samples. Weigh 10.0g of soil sample into 50 or 100 ml beaker, add 20ml of CaCl₂ solution (use water instead of CaCl₂ solution throughout the procedure if water is used as a suspension medium). Allow the soil to absorb CaCl₂ solution without stirring, and then thoroughly stir for 10 second using a glass rod. Stir the suspension for 30 minutes and record the pH on the calibrated pH meter.

Based on soil pH values, following types of soil reactions are distinguished Table-1

Table:1 Soil pH values

pH Range	Soil Reaction rating
<4.6	Extremely acid
4.6-5.5	Strongly acid
5.6-6.5	Moderately acid
6.6-6.9	Slightly acid
7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Strongly alkaline

The acidic soils need to be limed before they can be put to normal agricultural production. The alkali soils need to be treated with gypsum to remove the excessive content of sodium.

Electrical Conductivity Analysis:

The electrical conductivity (EC) is a measure of the ionic transport in a solution between the anode and cathode. This means, the EC is normally considered to be a measurement of the dissolved salts in a solution. Like a metallic conductor, they obey Ohm's law. Since the EC depends on the number of ions in the solution, it is important to know the soil/water ratio used. The EC of a soil is conventionally based on the measurement of the EC in the soil solution extract from a saturated soil paste, as it has been found that the ratio of the soil solution in saturated soil paste is approximately two-three times higher than that at field capacity. As the determination of EC of soil solution from a saturated soil paste is cumbersome and demands 400-500 g soil sample for the determination, a less complex method is normally used. Generally a 1:2 soil/water suspension is used.

Take 40 g soil into 250 ml Erlenmeyer flask, add 80 ml of distilled water, stopper the flask and shake on reciprocating shaker for one hour. Filter through Whatman No.1 filter paper. The filtrate is ready for measurement of conductivity. Wash the conductivity electrode with distilled water and rinse with standard KCl solution. Pour

some KCl solution into a 25 ml beaker and dip the electrode in the solution. Adjust the conductivity meter to read 1.412 mS/cm, corrected to 250 C. Wash the electrode and dip it in the soil extract.

Record the digital display corrected to 250°C. The reading in mS/cm of electrical conductivity is a measure of the soluble salt content in the extract, and an indication of salinity status of this soil the conductivity can also be expressed as mmhos/cm shown in Table-2

Table-2: Electrical Conductivity is a measure of the soluble salt content in the extract

Soil	EC (ms/cm)	Total salt content (%)	Crop reaction
Salt free	0-2	<0.15	Salinity effect negligible, except for more sensitive crops
Slightly saline	4-8	0.15-0.35	Yield of many crops restricted
Moderately saline	8-15	0.35-0.65	Only tolerant crops yield satisfactorily
Highly saline	>15	>0.65	Only very tolerant crops yield satisfactory

Nitrogen (Kjeldahl Method) Analysis:

Total N includes all forms of inorganic N, like $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$ and also NH_2 (Urea) -N , and the organic N compounds like proteins, amino acids and other derivatives. Depending upon the form of N present in a particular sample, specific method is to be adopted for getting the total nitrogen value. While the organic N materials can be converted into simple inorganic ammonical salt by digestion with sulphuric acid, for reducing nitrates into ammonical form, use of salicylic acid or Devarda's alloy is made in the modified Kjeldahl method. At the end of digestion, all organic and inorganic salts are converted into ammonium form which is distilled and estimated by using standard acid. As the precision of the method depends upon complete conversion of organic N into $\text{NH}_4\text{-N}$, the digestion temperature and time, solid: acid ratio and the type of catalyst used have an important bearing on the method. The ideal temperature for digestion is 320 – 370 °C. At lower temperature, the digestion may not be complete, while above 410°C, the loss of NH_3 may occur. The salt: acid (weight: volume) ratio should not be less than 1:1 at the end of digestion. Commonly used catalysts to hasten the digestion process are CuSO_4 or Hg. Potassium sulphate is added to raise the boiling point of the acid so that loss of acid by volatilization is prevented.

Weigh 1 g sample of soil. Place in Kjeldahl flask. Add 0.7 g copper sulphate, 1.5 g K_2SO_4 and 30 ml H_2SO_4 . Heat gently until frothing ceases. If necessary, add small amount of paraffin or glass beads to reduce frothing. Boil briskly until solution is clear and then continue digestion for at least 30 minutes. Remove the flask from the heater and cool, add 50 ml water and transfer to distilling flask. Take accurately 20–25 ml standard acid (0.1M HCl or 0.1M H_2SO_4) in the receiving conical flask so that there will be an excess of at least 5 ml of the acid. Add 2-3 drops of methyl red indicator. Add enough water to cover the end of the condenser outlet tubes. Add 30 ml of 35% NaOH in the distilling flask in such a way that the contents do not mix. Heat the contents to distil the ammonia for about 30-40 minutes. Remove receiving flask and rinse outlet tube into receiving flask with a small amount of distilled water. Titrate excess acid in the distillate with 0.1M NaOH. Determine blank on reagents using same quantity of standard acid in a receiving conical flask.

Calculation

$$\text{Percent N} = \frac{1.401 (V_1M_1 - V_2M_2) - (V_3M_1 - V_4M_2)}{W} \times df$$

Where,

V_1 - ml of standard acid taken in receiving flask for samples

V_2 - ml of standard NaOH used in titration

V_3 - ml of standard acid taken to receiving flask for blank

V_4 - ml of standard NaOH used in titrating blank

M_1 - Molarity of standard acid

M_2 - Molarity of standard NaOH

W - Weight of sample taken (1 g)

df - Dilution factor of sample (if 1 g was taken for estimation, the dilution factor will be 100).

Precautions

- The material after digestion should not solidify.
- No ' NH_4 ' should be lost during distillation.
- If the indicator changes colour during distillation, determination must be repeated using either a smaller sample weight or a larger volume of standard acid.

Results and discussions

ROSELLE

Effect of Fertilizer on Plant growth: As days are passing more enhancements in height is seen in case of fertilizer applied and it is much significant in Neem Oil Coated Urea (NOCU) as shown in the figure-1

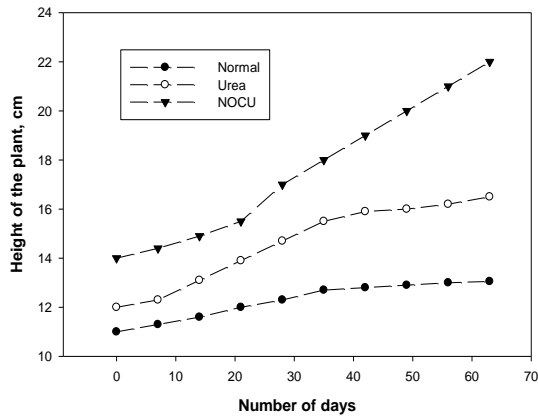


Figure:1 Height of the plant vs Number of Days

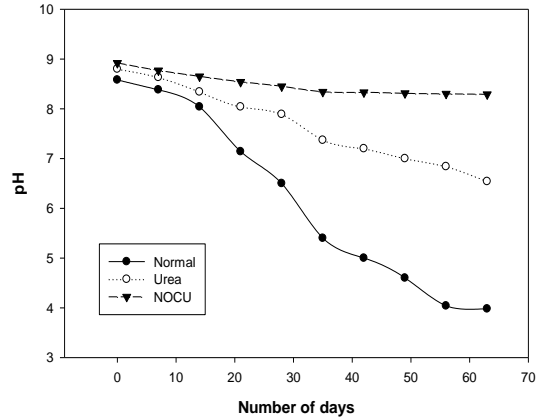


Figure:2 pH vs Number of Days

Effect of pH: As days are passing there is drastic decrease in pH in case of normal compared to fertilizers applied pH is more buffered in neem oil coated urea (NOCU) as shown in figure-2.

Effect of Electrical Conductivity: As days are passing electrical conductivity increases there is a significant rise is observed in neem8 oil coated urea compared to urea and normal cases as shown in figure-3.

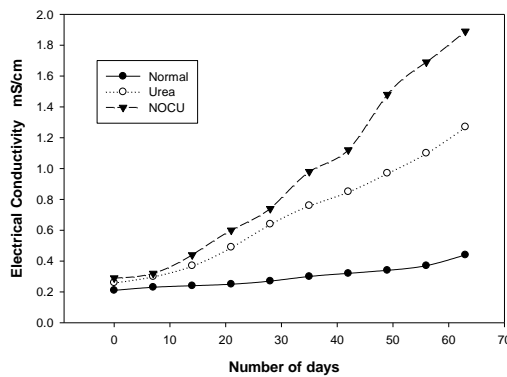


Figure:3 Electrical Conductivity, mS/cm vs Number of days

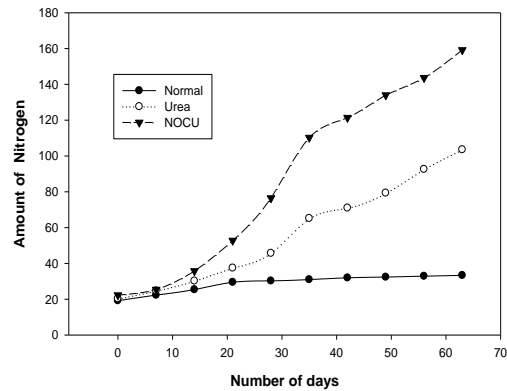


Figure:4 Amount of Nitrogen vs Number of days

Effect of nitrogen: As days are passing the amount of nitrogen increases in the soil there is much significance is seen in case of neem oil coated urea compared to other cases as shown in figure-4.

AMARANTHUS

Effect of fertilizer on plant growth: As days are passing more enhancements in height is seen in case of fertilizer applied and it is much significant in neem oil coated urea (NOCU) as shown in figure-5.

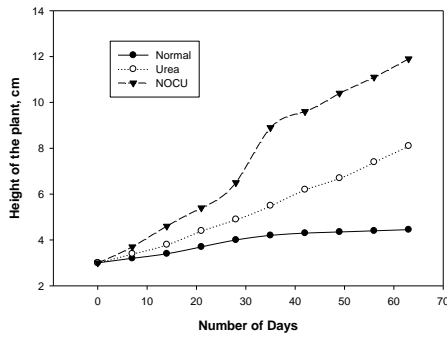


Figure:5 Height of the plant vs Number of days

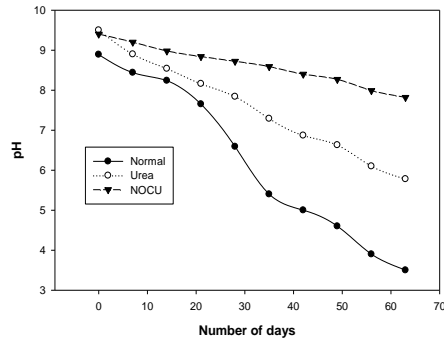


Figure:6 pH vs Number of days

Effect of pH: As days are passing there is drastic decrease in pH in case of normal compared to fertilizers applied pH is more buffered in neem oil coated urea (NOCU) as shown in figure-6.

Effect of electrical conductivity: As days are passing electrical conductivity increases there is a significant rise is observed in neem oil coated urea compared to urea and normal cases as shown in figure-7.

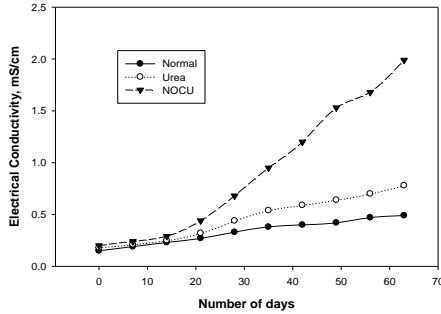


Figure:7 Electrical conductivity vs Number of days

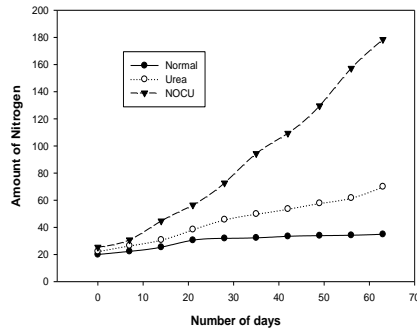


Figure:8 Amount of Nitrogen vs Number of days

Effect of nitrogen: As days are passing the amount of nitrogen increases in the soil there is much significance is seen in case of neem oil coated urea compared to other cases are shown in figure-8

Effect of nitrogen on plant growth: As the amount of nitrogen increases the height of the plant also increase it is more significant in case of neem oil coated urea for Roselle plant are shown in figure-9

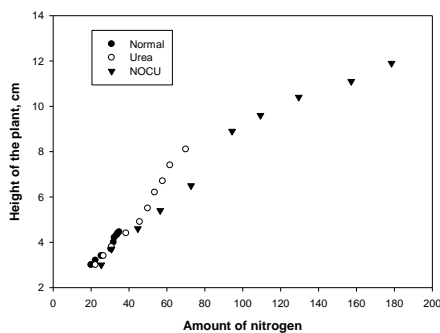


Figure:9 Height of the Plant vs Amount of Nitrogen

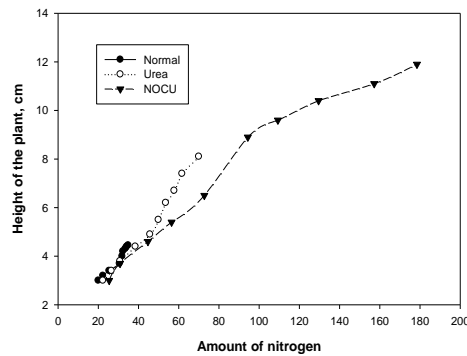


Figure: 10 Height of the plant vs Amount of nitrogen

Effect of nitrogen on plant growth: As the amount of nitrogen increases the height of the plant also increase it is more significant in case of neem oil coated urea for Amaranthus plant is shown in figure-10.

Conclusions

From the above experimental study, the following were the major Conclusions:

- ✓ Many proportions of neem oil and urea ratios like 1:2, 1:5 etc were prepared and combination castor oil coated urea proportions were prepared and are applied to plants. Initially we have performed water solubility test for samples prepared. It is observed that time taken for 1:5 neem oil coated urea as taken more time when compared other combinations. Next we have applied these samples to plants. There we were observed that 1:5 ratio neem oil coated urea plant has been served and other plants were died. From the above observations we confirm that 1:5 ratio neem oil coated urea can be used as controlled release fertilizer. After this we have taken two species of leafy vegetable plants Roselle and Amaranthus which are usually cultivated with two months of time.
- ✓ For these plants we have arranged three categories NORMAL: without applying any fertilizer to plant. UREA: applying urea fertilizer to plants. NOCU: neem oil coated urea applied to plants. These all plants were under observation. Soil samples were collected for consecutively for every 7 days and were sent for analysis to laboratory. As days are passing the growth of the plant is observed in neem oil coated urea it is very high compared to urea and normal.
- ✓ As days is passing pH of the soil decreases gradually and become more acidic as calcium is lost due to leaching by rainwater and irrigation. This effects the plant growth and absorbs the available nutrients to plants. This can be overcome by using neem oil coated urea (1:5 NOCU) compared to urea and normal.
- ✓ As days are passing electrical conductivity slowly rises this indicates that the available salts are increasing but it does not indicate which salt is increasing. This results in growth of the plant. This is high in neem oil coated urea (1:5 NOCU) compared to other urea and normal.
- ✓ As days are passing amount of nitrogen present in the soil increases gradually and enhances the growth of the plant. This nitrogen release is inhibited in neem oil coated urea release of nitrogen is controlled compared urea. As urea is readily soluble in water at a time the whole amount of nitrogen is released in to soil but the plant uptake is only 30% remaining nitrogen will enter into environment. This effect can be reduced in case of neem oil coated urea.
- ✓ It can widely apply to various types of soils and crops. The application of controlled-release fertilizer i.e. is neem oil coated urea will help to develop the high-yield, high-efficiency, high-quality agriculture.
- ✓ Compared with ordinary fertilizer, the plant height, stem diameter was significantly increased for controlled release fertilizer.
- ✓ Compared with ordinary fertilizer, the Roselle and Amaranthus were significantly increased for controlled release fertilizer.
- ✓ The application of controlled-release fertilizer has the minimal effects on soil environment, the highest nitrogen efficiency.
- ✓ The biggest economic efficiency because usually farmers apply urea three to four times for attaining high yield were as this controlled release fertilizer can be applied one to two depending on the duration of crop i.e. if it is two months crop we can apply one time. If it is six months crop we can apply two times.

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